Claims

1. A method of controlling an inductively-powered operating unit for use in association with an inductive power transfer (IPT) system, the method comprising frequency modulating the current in a primary conductor circuit of the IPT system and, in the operating unit:

(a) detecting the frequency of current in the primary conductor circuit;

(b) generating a local oscillator signal;

(c) using the local oscillator signal to detect a change in the frequency of the primary circuit current; and

(d) using the detected change to control the operating unit.

2. A method as claimed in claim 1 including the step of using the detected frequency to ascertain the frequency of the local oscillator signal.

3. A method as claimed in claim 1 or claim 2 wherein the step of generating the local oscillator includes generating a local oscillator of a known frequency with respect to the unmodulated frequency of the primary circuit current

4. A method as claimed in any one of claims 1 or claim 3 wherein the step of detecting a change in the frequency of the primary circuit current includes the step of subtracting the local oscillator signal from the detected frequency to provide an information signal, and detecting a change in the frequency of the information signal.

5. A method as claimed in any one of claims 1 or claim 3 wherein the step of detecting a change in the frequency of the primary circuit current includes the step of using the local oscillator signal to alias down the detected frequency to provide an information signal, and detecting a change in the frequency of the information signal.

6. A method as claimed in claim 4 or claim 5 wherein in the step of aliasing or the step of subtracting comprises the step of using a sample and hold circuit to sample the detected frequency signal to provide the information signal.

7. A method as claimed in claim 6 including the step of sampling the detected

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frequency at the frequency of the local oscillator signal.

8. A method as claimed in any one of claims 4 to 7 including the step of detecting the frequency of the information signal by counting the number of cycles or part cycles of an oscillating signal of constant frequency in each cycle or part cycle of the information signal.

9. A method as claimed in claim 8 including the step of counting the number of cycles or part cycles of the current in the primary conductor circuit in each cycle or part cycle of the information signal.

10. A method as claimed in any one of the preceding claims including the step of calibrating the frequency of the local oscillator signal with the frequency of the current in the primary conductor circuit.

11. A method as claimed in claim 10 wherein calibration includes the steps of detecting the frequency of the information signal, analysing the frequency over a pre-determined time period to obtain a frequency reference, comparing the frequency reference with a datum, and increasing or decreasing the local oscillator frequency to effect calibration.

12. A method as claimed in any one of the preceding claims including the step of establishing at least one pre-determined threshold associated with the frequency of the information signal, and comparing the frequency of the information signal with the threshold to provide a digital output signal for control of the operating unit.

13. A method as claimed in any one of the preceding claims including modulating the primary conductor current to provide an instruction to the operating unit, detecting one or more frequency changes associated with the modulation at the operating unit to decode the instruction, and controlling the operating unit in accordance with the instruction.

14. A controlled inductively powered unit for use in association with an inductive power transfer (IPT) system having a primary conductor circuit with a modulated current, the operating unit including:

(a) signal detection means for detecting the frequency of current in the primary conductor circuit;

(b) local oscillator means for providing a local oscillator signal;

(c) signal processing means adapted to use the local oscillator signal to detect a change in the frequency of the primary conductor current; and

(d) control means to control the operating unit dependent on the detected change.

15. A controlled inductively powered unit as claimed in claim 14 wherein the signal processing means ascertain the frequency of the local oscillator using the detected frequency provided by the signal detection means.

16. A controlled inductively powered unit as claimed in claim 14 or claim 15 wherein the local oscillator means provides a local oscillator signal of a known frequency with respect to the unmodulated frequency of the primary circuit current.

17. A controlled inductively powered unit as claimed in any one of claims 14 to 16 wherein the signal detection means provides a detected frequency signal representative of the frequency of the primary conductor current and includes comparison means to compare the frequency of the local oscillator signal with the frequency of the detected frequency signal to ascertain the frequency of the local oscillator signal.

18. A controlled inductively powered unit as claimed in any one of claims 14 to 17 wherein the signal detection means provides a detected frequency signal representative of the frequency of the primary conductor current and includes frequency subtraction means to subtract the local oscillator signal from the detected frequency signal and provide an information signal for detecting the change in frequency of the primary conductor current.

19. A controlled inductively powered unit as claimed in any one of claims 14 to 18 wherein the signal detection means provides a detected frequency signal representative of the frequency of the primary conductor current and includes sampling means which samples the detected frequency signal and provides an information signal for detecting the change in frequency of the primary conductor current.

20. A controlled inductively powered unit as claimed in claim 18 or claim 19 wherein the frequency subtraction means or the sampling means samples the detected frequency signal at the frequency of the local oscillator.

21. A controlled inductively powered unit as claimed in any one of claims 18 to 20, including a counter to detect the frequency of the information signal by counting the number of cycles or part cycles of an oscillating signal of constant frequency in each cycle or part cycle of the information signal.

22. A controlled inductively powered unit as claimed in claim 21 wherein the counter counts the number of cycles or part cycles of the primary conductor current circuit in each cycle or part cycle of the information signal.

23. A controlled inductively powered unit as claimed in any one of claims 18 to 22 including a comparator having a pre-determined threshold at one input and a signal representative of the frequency of the information signal at another input to provide a digital output signal for control of the operating unit.

24. A controlled inductively powered unit as claimed in any one of claims 14 to 23 including calibration means to calibrate the local oscillator signal frequency with the frequency of the current in the primary conductor circuit.

25. An inductive power transfer (IPT) system including a primary conductor circuit and one or more controlled inductively powered units as claimed in any one of claims 14 to 24 associated with the primary conductor circuit and adapted to receive power inductively from the primary conductor circuit, wherein the primary conductor circuit includes frequency modulation means to modulate the frequency of current in the primary conductor circuit.

26. A roadway lighting system comprising a plurality of separately controllable road-studs, each road-stud including a light emitting element and being powered inductively via a primary conductor circuit buried under or in a roadway, frequency modulation means adapted to modulate current in the primary conductor circuit, and wherein each controllable road-stud includes:

(a) signal detection means for detecting the frequency of current in the primary conductor circuit;

(b) local oscillator means for providing a local oscillator signal;

(c) signal processing means adapted to use the local oscillator signal to detect a change in the frequency of the primary conductor current; and

(d) control means to control the operating unit dependent on the detected change.

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~~25.~~ A roadway lighting system as claimed in claim 24 wherein the roadway is an automobile roadway.

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~~26.~~ A roadway lighting system as claimed in claim 24 wherein the roadway is an aircraft runway or taxiway.

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~~27.~~ A roadway lighting system as claimed in claim 24 wherein the roadway is a sidewalk or footpath.

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~~28.~~ A narrow band modulated data transmission system for controlling one or more light emitting units, the system including transmission means to transmit a modulated signal, and the or each light emitting unit including reception means tuned to receive the modulated signal, detection means to detect the data present in the received signal, and wherein the total power to operate the light emitting unit is derived from the received signal.

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~~29.~~ A narrow band modulated data transmission system as claimed in claim 28 wherein the transmitted signal is a frequency modulated signal.

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~~30.~~ A method of controlling one or more light emitting units comprising:
transmitting a narrow band modulated signal;
receiving the modulated signal at a light emitting unit;
detecting the data present in the received signal;
controlling the light emitting unit dependent on the detected data, and;
using the received signal to provide the total power to operate the light emitting unit.

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~~31.~~ A method as claimed in claim 30 including the step of transmitting a narrow band frequency modulated signal.

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~~32.~~ A method of controlling traffic on a road, the method including the steps of incorporating a road way lighting system comprising a plurality of separately controllable road-studs into or onto the road, each road-stud including a light emitting element and

being powered inductively via a primary conductor circuit buried under or in a roadway, frequency modulation means adapted to modulate current in the primary conductor circuit, and wherein each controllable road-stud includes:

(a) signal detection means for detecting the frequency of current in the primary conductor circuit;

(b) local oscillator means for providing a local oscillator signal;

(c) signal processing means adapted to use the local oscillator signal to detect a change in the frequency of the primary conductor current; and

(d) control means to control the operating unit dependent on the detected change, and

modulating the frequency of current in the primary conductor circuit to initiate a pattern of operation of each controllable road-stud such that the plurality of road-studs provide a message to users of the road.

35. ~~33.~~ A method as claimed in claim 32 including the step of modulating the frequency such that the message includes sequential flashing of the controllable road-studs to indicate a direction.

36 ~~34.~~ A method as claimed in claim 32 including the step of modulating the frequency such that the message includes sequential flashing of the controllable road-studs to indicate a speed limit.

37 ~~35.~~ A method as claimed in claim 33 or claim 34 wherein the step of sequential flashing involves activating all the light emitting elements and sequentially deactivating a minority of the light emitting elements.

38 ~~36.~~ A controllable road-stud system including:

a power supply for generating a substantially sinewave current in a primary conductive path characterised in that the frequency of the current can be modulated,

a plurality of active nodes tuned to the power supply frequency located at specific points along the primary conductive path,

a road-stud tuned to the power supply frequency located in close proximity to each of the active nodes,

each road-stud including:

a pick-up coil with a tuning capacitor,

rectification means for producing a DC source of power,

control means for controlling the power flow from the primary conductive path to the road-stud,
a light source means in series with a controllable switch connected across the DC source of power and active to switch the light source means on or off,
signal detection means for detecting the frequency of the current in the primary conductive path or the current in the pick-up coil,
means for producing a local oscillator signal at a known frequency relative to the detected frequency,
means for tracking the local oscillator signal frequency against variations in frequency or components
means for producing a signal representative of the difference frequency between the detected frequency and the frequency of the local oscillator signal,
counting means for counting the number of cycles of the detected frequency in one cycle of the difference signal,
comparator means for determining whether the counted number of cycles is greater or less than a comparison fixed number to provide a decoded output, and
processor means to control the light source means on the road-stud according to the decoded output.

39. ~~37.~~ A controllable road-stud for use in association with an inductive power transfer (IPT) system having a primary conductive path with a frequency modulated current, the road-stud including:
means for producing a local oscillator signal in the road-stud of known accuracy with respect to the unmodulated frequency of the current in the track,
means for using the local oscillator signal to detect changes in the frequency of the current in the primary conductive path,
means for converting the detected changes to digital form to produce binary output representative of the modulation of the frequency of the current in the primary conductive path,
a processing device for interpreting the binary output and driving switch means for switching a light source powered by the road-stud on or off as appropriate.

40. ~~38.~~ A controllable road-stud as claimed in claim 37 wherein variations in the local oscillator frequency caused by component differences or changes in temperature or time are compensated for even though these changes may be significantly larger than the controlled frequency changes in the track current.

41. ~~39.~~ A controllable road-stud as claimed in claim 37 or claim 38 wherein the primary conductive path includes one or more active nodes.

42 ~~40.~~ A controllable road-stud as claimed in claim 39 including a pick-up coil, and wherein variations in the tuning of the active node or the pick-up coil have substantially no affect on the ability of the apparatus to produce and process the binary output.

43. ~~41.~~ A controllable road-stud as claimed in any one of claims 37 to 39 wherein the modulation of the current in the primary conductive path is in a range of substantially 1-1.5% of the unmodulated frequency of the current in the primary conductive path.

44. ~~42.~~ A controllable road-stud as claimed in any one of claims 37 to 41 wherein the light source is capable of displaying more than one colour or a plurality of light sources are provided, and the processor may selectively switch that colour or those colours on or off in a desired sequence or pattern.

45. ~~43.~~ A road-stud system including a controllable road-stud as claimed in any one of claims 37 to 42 and one or more uncontrolled road-studs, all the road-studs being powered from the same primary conductive path and all the road-studs functioning without affecting the each other.

46. ~~44.~~ A road-stud system as claimed in claim 43 wherein each controlled road-stud can operate one or more light sources of different colours in any desired sequence of patterns and colours.

47. ~~45.~~ A method of controlling an inductively-powered operating unit for use in association with an inductive power transfer (IPT) system substantially as herein described with reference to the drawing.

48. ~~46.~~ A controlled inductively powered unit for use in association with an inductive power transfer (IPT) system substantially as herein described with reference to the drawing.

49. ~~47.~~ An inductive power transfer (IPT) system substantially as herein described with reference to the drawing.

50. ~~48.~~ A narrow band frequency modulated data transmission system for controlling one or more light emitting units substantially as herein described with reference to the drawing.

51. ~~49.~~ A method of controlling traffic on a road substantially as herein described with reference to the drawing.

52. ~~50.~~ A controllable road-stud system substantially as herein described with reference to the drawing.

53. ~~51.~~ A controllable road-stud substantially as herein described with reference to the drawing.

54. ~~52.~~ A system for controlling one or more light emitting units, the system including a narrow band modulated data transmission system for controlling one or more light emitting units, and an IPT system, the data transmission system including transmission means to transmit a modulated signal, and the or each light emitting unit including reception means tuned to receive the modulated signal, and detection means to detect the data present in the received signal, and the IPT system providing power to the light emitting unit.